Evaluating the Role of Pesticides on Amphibian Fitness

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Introduction

With the rapid increase in demand for land and resources, pesticides have often been utilized to maximize the overall outcome of usable crops, and to maintain landscapes for human benefit. With a continuous rise of threats like global warming, deforestation and changing weather patterns, it calls for research and identification of how humans continuously play a role in impacting the Earth. Much of human industrialization and agriculture disrupts and displaces wildlife with no alleviation in sight. While golf courses are modifications of natural habitats, the ecological value is still high, since they are still large contributors to the conservation and preservation of wildlife; thus, there appears to be a positive correlation between land with high levels of anthropogenic impact and ecological value (Colding & Folke, 2009). With the management of golf courses in the United States, the chemicals that are often used can affect water quality, aesthetics and native beneficial organisms via water runoff. For instance, glyphosate, a frequent used herbicide, has been found in the surface water of several waterways (Baris et al., 2010). Pollutants such as this accumulate into waterways and consequently can harm native wildlife far from the point source.

American toads are common amphibians throughout the eastern United States and are often inhabitants of areas with high moisture levels like parks, farmland, forests and golf courses (Lannoo, 2005). When high precipitation areas across the country are treated with nutrients and pesticides, biodiversity of communities are at risk. In a study that inspected four common pesticides, it was determined that these pesticides caused a reduction in species richness and Roundup®, particularly, was completely toxic for two species of tadpoles, and nearly a third, which resulted in a significant decrease in species richness. (Relyea, 2011). This impacts the quality of life of these organisms and their ability to contribute to the ecosystem. It is imperative to understand and further examine how pesticides at environmentally relevant concentrations affect adjacent communities, particularly amphibians. Therefore, the data regarding the environmental contaminants and their effects, merits further investigation in order to observe and quantify the extent of harm being infringed on these communities.

Objectives & Hypotheses

- Quantify the degree to which the commonly used herbicide, glyphosate (found in Roundup®) affects the development American toads (Anaxaruys americanus).
- Create an experimental unit that mimics a natural environment and use computerized tomography (CT) scan to analyze metamorphic individuals following development treatments that contain Roundup and components that are used to inoculate plants with Roundup.
- Evaluate the scans to determine which interaction of the experimental variables have an abnormal effect on the development of amphibian communities.

Predictions

- H1: Inoculation of glyphosate will lead to stronger direct impacts on development of American toads.
- H2: Additions of compounds used to inoculate vegetation (e.g., surfactant and dye) alone will not have measurable impacts on the development of American toads.
- H3: The combination of glyphosate and additional compounds will not further impact the development of American toads compared to glyphosate alone treatments.

Methods

- In spring 2019, 33, 35L above ground mesocosms were set up on the roof of LSB to raise American toads under the following treatments: control, glyphosate low concentration, glyphosate high concentration, surfactant, dye, glyphosate low + surfactant, glyphosate high + surfactant, glyphosate low + dye, glyphosate high + dye, glyphosate low + surfactant + dye, glyphosate high + surfactant + dye.
- Using the specimens collected in spring/summer 2020 as metamorphic frogs from these treatments, computerized tomography (CT) scanner was used with the Cu 0.06mm+Al0.5m x-ray filter, and a medium sized boar chamber and bed to create 3D images of each specimen collected across treatments.
- The CT scan unit had both voltage (kV) and current (uA) set to 80, acquisition to 36 and recon to 25.
- Specimen will be prepared by placing in clear plastic bag, and place on the full body portion of the scanner.
- Each specimen was scanned at high resolution for 57 minutes, from which a 3D rendering was created using 3D Slicer (Fig. 1)
- Following scan and image creation, MeshLab was used to analyze the experimental specimens for their bone lengths and compare with control metamorphs (Fig. 2)
- One-way analysis of variance to determine whether differences exist and the extent the treatments affected the metamorphic frog development

Results

Figure 1: CT scanner used to generate 3D renderings of each specimen

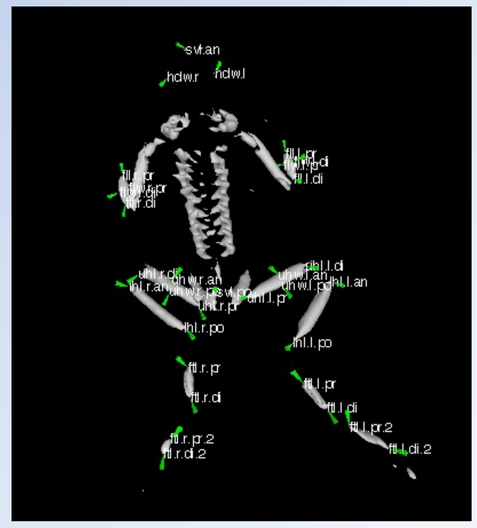

Figure 2: Landmarks were placed on each specimen using MeshLab

Future Directions

- Continue using CT scanning and 3D Slicer to create 3D renderings of the amphibians.
- Utilize MeshLab to create landmarks on the skeletons of each specimen.
- Analyze measurements from landmarks
- Employ data analysis to determine if glyphosate affects the development of American toads.

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